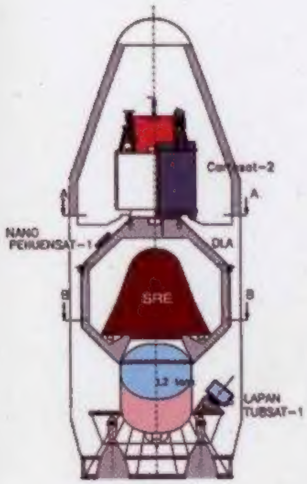
INDIAN SPACE RESEARCH ORGANISATION
INDIA
PSLV C7
CARTOSAT - 2 / SRE
MISSION

PSLV C7 MISSION



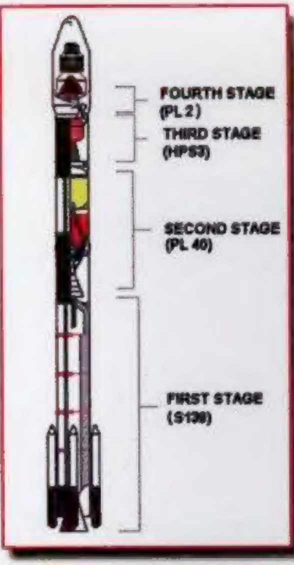
PSLV-C7, the seventh operational flight of Polar Satellite Launch Vehicle is primarily aimed at deploying ISRO's remote sensing satellite CARTOSAT-2 and the Space Capsule Recovery Experiment module SRE. This tenth flight in PSLV series also carries two passenger payloads viz., LAPAN TUBSAT from Indonesia and NANO PEHUENSAT from Argentina. The launching of two numbers of 600 kg class satellites in a single launch is made feasible with the use of a structure called Dual Launch Adapter (DLA). The dual launch concept is being attempted by ISRO for the first time.

MISSION SPECIFICATION

Orbit	:	635.4 km SSPO
Inclination	:	97.92 °
Launch time	:	09:23 hrs IST
Launch station	:	First Launch Pad
Launch Azimuth	:	140 °

MAJOR CHANGES

- Altitude based Day of Launch (DOL) wind biased steering program during Open Loop Guidance
- Deletion of SITVC system of airlit strap-on
- Reduction of PS1 SITVC injectant loading by 500 kg
- Use of externally fabricated nozzles for two PSO motors
- Use of Dual Launch Adapter (DLA)
- Use of 2 t liquid stage for PS4 stage
- Video Imaging System to capture payloads (Cartosat-2 & SRE) and DLA separation events
- Vehicle Structural dynamic characteristics change due to internal vehicle length increase by 2.25 m with the introduction of DLA
- Flight sequence modified to cater to multiple satellite / DLA separation



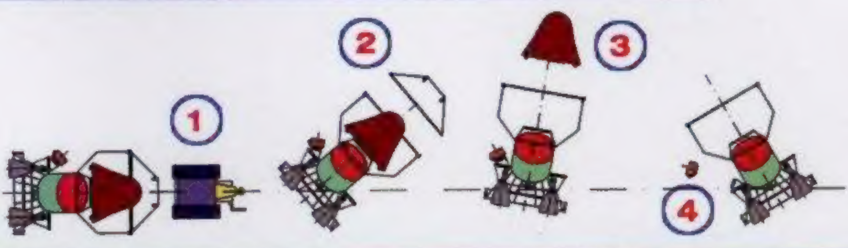
VEHICLE

The vehicle configuration for PSLV C7 mission essentially remains same as PSLV C6 except for the changes mentioned under the section major changes.

Overall height	:	44.4 m
Lift-off mass	:	295.26 t
First stage	:	PS1 (S139) + 6 PSOMs, HTPB based Solid propellant
Second stage	:	PS2 (PL40), UH25 + N_2O_4 Liquid propellant
Third stage	:	HPS3, HTPB based Solid propellant
Fourth stage	:	PS4 (PL2), MMH + MON Liquid propellant

FLIGHT PROFILE

EVENT	TIME (s)	ALTITUDE (km)	VELOCITY (km/s)
Ignition of PS1	0.0	0.024	0.452
Ignition of 4 ground-lit PSOMs	1.2	0.024	0.452
Ignition of 2 air-lit PSOMs	25.0	2.528	0.551
Separation of 4 ground-lit PSOMs	68.0	23.757	1.135
Separation of 2 air-lit PSOMs	90.0	42.768	1.628
Separation of PS1	113.63	70.008	1.989
Ignition of PS2	113.83	70.239	1.988
Heat Shield Separation	159.63	121.957	2.300
Separation of PS2	264.62	235.934	4.067
Ignition of PS3	265.82	237.303	4.064
Separation of PS3	513.36	496.624	6.070
Ignition of PS4	533.50	512.238	6.048
Cut-off of PS4	942.56	638.613	7.536
Cartosat-2 Separation (1)	979.56	639.194	7.539
DLA-U Separation (2)	1024.56	639.943	7.539
SRE Separation (3)	1099.56	641.271	7.539
Lapan-Tubsat Separation (4)	1169.56	642.554	7.538



DUAL LAUNCH ADAPTER

DUAL LAUNCH ADAPTER (DLA), is developed for carrying two medium class (~1000 kg) satellites in PSLV. DLA, made of honeycomb sandwich shells with Carbon fibre composite (G969 /Epoxy) facing sheets and Aluminium core, is configured as three substructures viz., DLA-U (Upper), DLA-M (Middle) and DLA-L (Lower). End rings made out of Aluminium AA2014 alloy is provided at both ends of all the three substructures. DLA-U and DLA-L are conical structures while DLA-M is a cylindrical structure

DLA is mounted on PS4 tank by bolting DLA-L along with Payload Adapyer (PLA). Aft end of DLA-M is bolted to DLA-L forward end. DLA-U is placed on top of DLA-M and assembled together by a band clamp separation system. DLA-U carries top payload, Cartosat-2 through a band clamp separation system and second payload, SRE is mounted on PLA fore end through another band clamp separation system. DLA is provided with cutouts of various sizes to facilitate assembly of structure, sensors, electrical connectors and cooling of satellite mounted on PLA.

DLA is a long structure which is encapsulated in payload fairings and it has to carry a satellite of significant mass at the forward end, which will cause some changes in the dynamic characteristics of the vehicle particularly during the PS4 regime. Hence all dynamic characteristics and response of the vehicle at important dynamic events like PS2 burn-out, responses to gust and vibration characteristics are re-evaluated to asses the impact on digital autopilot design, payload envelope estimation and satellite responses. Dynamic characterization test, structural test, re-verification of dynamic characterization and separation test were carried out as part of qualification of DLA.

SRE INTEGRATION WITH DLA & VEHICLE

CARTOSAT-2

INDIA 684 kg

CARTOSAT-2 spacecraft is primarily designed to meet the cartographic requirements of the nation and is equipped with a better than 1 m resolution remote sensing camera. The primary mission objectives of the spacecraft are :

- Obtaining high resolution scene specific spot imageries from a highly agile platform in step and stare mode
- Generating maps for land use planning and urban survey

The above objectives are met using linear array 12k CCD panchromatic camera. The orbit is decided based on the illumination and revisit time. The revisit cycle is 4 days for the 635 km SSPO. The S/C is expected to have a mission life of 5 years. It also has a provision to come down to 560 km and go back to 635 km once in its lifetime.

The S/C will use for the first time a Bus Management Unit (BMU) that supports Telemetry, telecommand, sensor processing, thermal control and control electronics. This replaces three separate packages that were used in the earlier S/Cs for the same functions. The S/C power system consists of four deployable solar panels and two 18 Ah batteries to provide power for peak demand in eclipse mode. The RCS system uses monopropellant of Hydrazine for in-orbit control. The S/C attitude control is achieved by sun pointing and star trackers. Magnetometers are used for coarse attitude references based on knowledge of local geometric field and measurement in three orthogonal axes.

Cartosat-2 will be the first spacecraft to fly on top of the DLA and the separation system employing the band clamp mechanism will provide a separation velocity of around 1.2 m/s.

CARTOSAT-2 INTEGRATION SEQUENCE

INDIA 555 kg

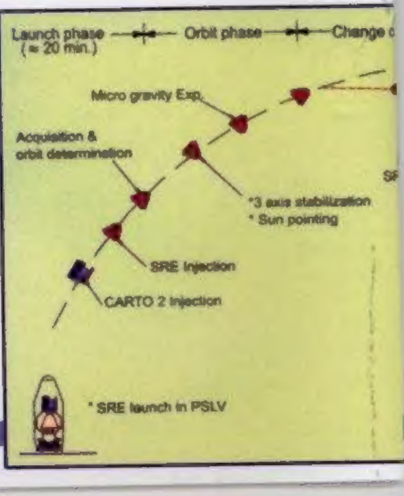
The main objective of Space Capsule Recovery Experiment (SRE) mission is to demonstrate our capability to recover an orbiting capsule safely back on earth. It will also provide a platform for conducting long duration orbital microgravity experiments. The sphere-cone-flare shaped SRE capsule, having a total mass of 555 kg, is the first spacecraft to be accommodated inside the DLA on the PLA. The separation system is band clamp system with a separation velocity of around 0.9 m/s.

In orbit, SRE will be in 3 axis stabilized sun pointing mode and two microgravity experiments will be carried out : ICO crystal growth Ga-Mg-Zn alloy (IISc- VSSC) and Bio mimetic material synthesis of hydroxy aptite (National Metallurgical Laboratory, Jamshedpur).

After being in orbit for 12 days, SRE will be de-boosted for re-entry under closed loop guidance and enters atmosphere at 100 km altitude with a speed of 7.9 km/s at M 30. The aerodynamic braking provided by drag of its shape will reduce the velocity to 95 m/s at 5 km. During 80 km to 30 km flight, SRE will be subjected to severe aerodynamic heating (250 W/cm^2) and deceleration (9 g). The thermal protection system, consisting of Carbon phenolic nose cap, reusable Silica tiles in cone flare region and low density ablatives at flare end, will protect the internal packages from heating.

Since the plasma generated by aerodynamic heating surrounds the module, there will be communication blackout. SRE is equipped with a number of useful aero-thermo-structural measurements. During blackout, the data will be stored in memory and will be played back to ground stations once it comes out of blackout around 40 km.

Below 5 km, the deceleration of the capsule to 12 m/s at splash down is achieved using a three stage parachute system. The module will splash down in the sea 140 km off SHAR coast and will float with the aid of a flotation system. With the help of locating beacons and coloring dye , SRE will be recovered by Indian Coast Guard with assistance from Indian Navy. The key technologies developed for SRE, such us reusable thermal protection system, NGC for de-boost, models for hypersonic aero-thermo dynamics, space qualified parachute systems, locating aids, etc., will lay a strong foundation for our Reusable Launch Vehicle technologies.



LAPAN - TUBSAT

INDONESIA 56 kg

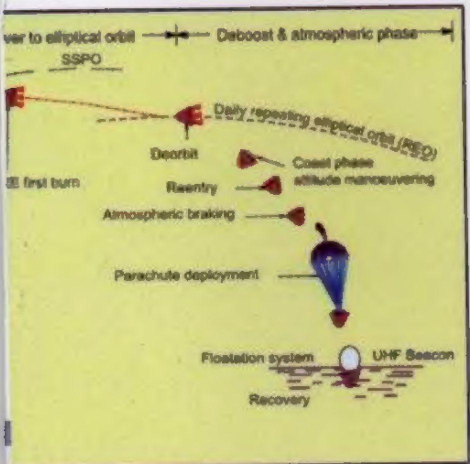
LAPAN-TUBSAT is a video surveillance microsatellite developed as a cooperation project between Lembaga Penerbangan dan Antariksa National of Indonesia and Institute fur-Ind Raumfahrt of TU Berlin, Germany. The S/C attitude and so the camera pointing can be manipulated off-nadir thereby shortening the ground repeat time which otherwise will take longer time.

The payload consists of a wide angle camera and a 5 m resolution camera. While the wide angle camera is used to determine and select the general location of imaging, the high resolution camera is used to zoom in to the area to obtain better images. The S/C also conducts store and forward communication experiments with Indonesian Radio Amateur Society and Universities. One of the objectives of this mission is to collect data on volcanic activity from sensors on the mountains and transmit to the University's ground station. The power system consists of five NiH_2 batteries with 8Ah rating and 12.5V and four body mounted solar panels.

NANO PEHUENSAT

ARGENTINA 6 kg

NANO PEHUENSAT is a small microsatellite developed by the Argentine Association for Space Technology, an educational, non-profit organization based in Buenos Aires, Argentina, jointly with the University of Comahue of Argentina and AMSAT (Amateur Satellite Association of Argentina).



NANO PEHUENSAT provides an experiment platform to perform amateur radio experiments between colleges and universities of Argentina and other countries. The satellite has a voice digitalizer and will transmit satellite health parameters to Earth in three languages : Spanish, English and Hindi. The data can be received using a 148 MHz HAM receiver. The S/C is expected to have a mission life of one month and will orbit the earth along with DLA-U.

C7 LAUNCH CAMPAIGN ACTIVITIES

CBS + NES

STRAP-ON MOTOR

FIRST STAGE

SECOND STAGE

THIRD STAGE

FOURTH STAGE

DUAL LAUNCH ADAPTER

SRE + CARTOSAT-2 AT LAUNCH PAD

OPERATIONAL FLIGHTS

PSLV-C1	29 September 1997	IRS-1D
PSLV-C2	26 May 1999	IRS-P4, KITSAT, TUBSAT
PSLV-C3	22 October 2001	TES, PROBA, BIRD
PSLV-C4	12 September 2002	KALPANA-1
PSLV-C5	17 October 2003	IRS-P6
PSLV-C6	5 May 2005	IRS-P5, HAMSAT

PUBLISHED BY : DOCUMENTATION SECTION, PSLV PROJECT, VSSC, VALIAMALA, TRIVANDRUM
PRINTED AT : ST. JOSEPH's PRESS, TRIVANDRUM

design : ss vinod / pslv project